

We claim:

1. A method of reducing pathogens in a mammal's blood stream by exposing the blood in an extracorporeal fluid with nitric oxide, comprising:
  - (a) providing an extracorporeal blood circuit comprising an inlet line adapted to receive blood from a patient or a blood source, an outlet line adapted to return blood to the patient and/or the blood source, a fluid circuit for fluid communication between the inlet and the outlet line, and at least one pump acting on the fluid circuit to circulate blood therethrough and out the outlet line,
  - (b) circulating the blood through the extracorporeal blood circuit, and
  - (c) exposing the blood in the circuit with nitric oxide gas in a concentration sufficient to reduce pathogenic content in the blood.
2. The method of claim 1 further comprising including in the circuit a blood treatment component, treating blood with the component, and at least upstream of the component contacting blood in a portion of said circuit with nitric oxide gas in concentration sufficient to reduce pathogenic content in the blood.
3. The method of claim 2 further comprising selecting said component from the group consisting of a dialysis component, an organ perfusion component, a heat exchange component, an oxygenation component, or a combination thereof.
4. A method of reducing pathogens in blood in an extracorporeal fluid circuit of a cardiopulmonary bypass apparatus, comprising:
  - providing a cardiopulmonary bypass circuit that includes an inlet line adapted to receive blood from a patient or a blood

source and an outlet line adapted to return blood to the patient and/or blood source, a reservoir connected to the inlet line for accumulation of blood received from the patient, an oxygenator, a fluid interconnection circuit for fluid communication between  
5 the reservoir and the oxygenator and between the oxygenator and the outlet line, and at least one pump acting on the fluid interconnection circuit to withdraw blood from the reservoir and circulate it through the oxygenator and out the outlet line, and exposing the blood in a portion of the cardiopulmonary  
10 bypass circuit with nitric oxide gas in concentration sufficient to reduce pathogens in the blood.

5. The method of claim 4 further comprising:

monitoring the rate of flow of blood through the cardiopulmonary bypass circuit,

15 introducing nitric oxide gas into the circuit, and controlling the pressure and rate of flow of gas introduced into the circuit in relation to the flow of blood through the circuit to maintain the concentration of nitric oxide within a desired range sufficient to reduce pathogens of the blood.

20 6. The method of claim 4 comprising introducing nitric oxide into a blood accumulator reservoir receiving blood from the patient for exposing with the blood.

7. The method of claim 4 comprising

25 locating a semipermeable membrane selectively permeable to nitric oxide gas and impermeable to nitrogen gas in a portion of said fluid interconnection circuit distally proximate the reservoir in a longitudinal disposition adapted to allow contact of an outside of the membrane with blood flowing through the fluid interconnection circuit portion, and

30 delivering nitric oxide gas to the inside of the membrane under pressure sufficient to drive the nitric oxide across the membrane for contact with blood on the outside of the membrane

within a desired concentration range sufficient to reduce pathogens in the blood.

8. The method of claim 7 further comprising

providing the membrane in tubular form having an inlet and  
5 outlet and in coaxial disposition within the fluid  
interconnection circuit portion,

delivering the nitric oxide with a nitrogen carrier gas  
through the inlet and removing gas through the outlet sufficient  
to maintain the pressure and rate of flow, and

10 scavenging any nitric oxide present in the gas removed  
through the membrane outlet.

9. The method of claim 1 wherein the pathogens are septicemia  
and/or bacteremia.

10. The method of claim 4 wherein the pathogens are septicemia  
15 and/or bacteremia.

11. The method of claim 1 wherein the nitric oxide gas is mixed  
with other gases.

12. The method of claim 4 wherein the nitric oxide gas is mixed  
with other gases.

20 13. The method of claim 1 further providing a free-radical  
scavenger unit that exposes the blood to free-radical scavengers  
after the blood is exposed to the nitric oxide.

14. The method of claim 4 further providing a free-radical  
scavenger unit that exposes the blood to free-radical scavengers  
25 after the blood is exposed to the nitric oxide.

15. An extracorporeal blood circuit comprising an inlet line  
adapted to receive blood from a patient or a blood source, an  
outlet line adapted to return blood to the patient and/or the  
blood source, a fluid circuit for fluid communication between  
30 the inlet and the outlet line, and at least one pump acting on  
the fluid circuit to circulate blood therethrough and out the  
outlet line,

a nitric oxide unit that exposes the blood in the circuit with nitric oxide gas in a concentration sufficient to reduce pathogenic content in the blood; and

5 a free radical scavenger unit that exposes the blood in the circuit and after being exposed to nitric oxide, with a free-radical scavenger in a concentration sufficient to reduce the nitric oxide content in the blood.

16. A nitric oxide gas dispenser for mammals, comprising:

10 a component that provides nitric oxide gas and or aerosolized composition at a desired pressure and concentration, and a delivery system that provides the nitric oxide at the desired pressure to the mammal;

15 a valve mechanism that controls the flow of the nitric oxide so the mammal's lungs receive a predetermined amount of nitric oxide and the nitric oxide is of sufficient quantity that it is able to penetrate through the mammal's lungs to contact the mammal's blood cells to reduce the pathogens in the mammal's blood and not form excessive amounts of methemoglobin.

17. The dispenser of claim 16 wherein the dispenser has a  
20 pressure sensor positioned along the delivery system and determines when the mammal is taking a breath;

if the pressure sensor determines the mammal is taking a breath, the pressure sensor transmits a breath signal to a microprocessor, the microprocessor then determines if the mammal  
25 is within a prescribed time frame for the mammal to be administered nitric oxide;

if the microprocessor determines the mammal is within the prescribed time frame, the microprocessor transmits an open signal to the valve mechanism to release the predetermined  
30 amount of nitric oxide to the mammal to reduce pathogens in the blood system.

18. The dispenser of claim 16 wherein the nitric oxide is transmitted into at least one nostril of the mammal, or the mouth of the mammal, or through a ventilator.

5 19. The dispenser of claim 16 wherein the pathogens are septicemia and/or bacteremia.

20. The dispenser of claim 16 wherein the nitric oxide is mixed with other gases.

21. A method of reducing pathogens in a mammal's blood stream by exposing the blood that receives oxygen from the lungs with  
10 nitric oxide, comprising:

(a) administering nitric oxide from a nitric oxide dispenser unit to a mammal through a nasal canula, a mask or a ventilator circuit for a mammal breathing or on ventilator like support;

15 (b) exposing the blood in contact with the patient's lungs with nitric oxide in a concentration sufficient to reduce pathogenic content in the blood.

22. The method of claim 21 wherein the pathogens are septicemia and/or bacteremia.

20 23. The method of claim 21 wherein the nitric oxide is a gas.

24. The method of claim 21 wherein the nitric oxide is delivered through an aerosolized donor compounds.

25. The method of claim 21 wherein the nitric oxide is mixed with other gases.